

are hundreds of times sharper than those likely to come from the Hubble Space Telescope. The program includes separate telescopes with vast collecting areas—an 8- to 16-meter optical telescope, say, or a gamma-ray telescope for energies above 2 MeV—that would gather scarce photons by the bushel. The board also calls for a new high-resolution cosmic-ray spectrometer using superconducting magnets for research in particle astrophysics, and for a vigorous exploration program carried out by Explorer-class satellites to provide a baseline for future studies.

Fundamental physics and chemistry. The board sees exciting opportunities for high-sensitivity tests of general relativity and gravitational waves, using such techniques as a laser observatory to detect gravitational radiation at frequencies below 10 Hz from space and a hydrogen maser clock on board a spacecraft that could measure the gravitational redshift to second order. It also suggested the possibility of studying the behavior of matter under conditions of weightlessness—the materials processing research that NASA has advanced as an important reason for building the space station. While the board agreed that interesting work could be done in this subject, it says little is known about the basic scientific questions. “Until these are answered,” the report states matter-of-factly, “there does not seem to be any way to structure a rational program of materials processing in space.”

Life sciences. Among the most vexing unanswered questions are those involving the origin and evolution of global biota in space and interactions with life on Earth. In addition, if the US eventually decides to go ahead with a colony on the Moon or an expedition to Mars, human life in space demands a better understanding of how weightlessness degrades bone and muscle, what kind of shielding astronauts would need in the interplanetary environment and what it would take to develop a reliable ecosystem for recycling wastes on flights extending for months or years.

In the penultimate chapter, the board admits it had difficulty determining which scientific projects, other than those in space medicine, “compel the presence of humans in space. In fact, there may be no others.” Board members clearly know that humans can function in support of science in space, but “at present we lack enough information to judge where the balance between manned and unmanned missions should lie.”

Collaboration or competition

The concluding section seems to say the board prefers international cooperation to world rivalry in space science. It is careful to point out that the US needs to be wary about disruptions that result from “unanticipated changes in the relationship that may be imposed for reasons that are outside the scientific programs.

In a letter sending the Donahue Report to NASA Administrator Fletcher, Frank Press, president of the National Academy of Sciences, writes that the findings and recommendations “probably constitute, in aggregate, a much larger space science program than can be realistically anticipated in the period of time examined in the study.” Press acknowledges that the board members are aware of this, particularly in light of the painful lessons of the past few years.

For its part, the board urges NASA to make science “an objective no less central to the space program of the US than any other.” The message is clear but unstated: If NASA is bent on taking on spectacular feats of engineering for the sake of national pride and prestige, or to further military and commercial causes, it may be best to separate scientific research from the rest. This topic, however, was hardly discussed at the symposium.

Nevertheless, in his remarks at the symposium, Donahue emphasized that the program the board outlined for the coming decades heralds a true golden age of understanding and advancement. The justification for the huge investment in space science, he says, has its own intrinsic worth: It provides answers to some of the most fundamental questions in nature; it contributes to the scientific and technological prowess of the nation; it stirs mankind’s imagination and broadens perspectives.

—IRWIN GOODWIN

DEFENSE SCIENCE BOARD URGES PRESIDENT TO COORDINATE MILITARY WITH ECONOMIC PLANS

Throughout the long and often caustic 1988 Presidential campaign, the issues heard most—patriotism, family values, crime, prison parole—were matters of personal and state responsibility, not those the new Administration can do much about. By contrast, in the transition between the Reagan and Bush periods, many of the transcending realities facing the government are up for debate: the budget deficit, economic competition, industrial innovation, scientific preeminence. All of these problems are discussed in a report of fewer than 65 pages, issued two days after the election by a task force of the Defense Science Board. The report is directed at measures the President should take to reverse “an increasing loss of technological leadership to both our allies and adversaries.”

Designated to examine conditions in the defense technology and industrial base, the task force found that push has come to shove. “The days of Fortress America are past,” it asserts. The evidence suggests that military research and production are in decline, with far-reaching consequences. Persistent deterioration of the nation’s technology and dependence on foreign suppliers for such critical components in weapons systems as semiconductors, machine tools and precision optics have “diminished the credibility of our deterrent,” the report declares.

Woes of defense business

The 28-member panel, headed by Robert A. Fuhrman, chairman, president and chief operating officer of Lockheed Corp, argues that the US

defense industry has not made sufficient long-term investment because of a propensity for the Defense Department to adopt short-term goals. To be sure, says the Fuhrman Report, blame for this can be placed on fluctuations in Federal funding and equivocations in Pentagon procurements. The panel also is concerned about the perception of investors and contractors of the disparity between the risks of weapons production and the rewards for defense business.

The science board report comes as many in the Pentagon, Commerce Department and Congress worry about US dependence on foreign manufacturers and suppliers for advanced military technologies. A decline in US industrial competitiveness had been decried as a national security issue in reports by the Congressional

Office of Technology Assessment and the National Research Council. Last July, Robert B. Costello, undersecretary of Defense for acquisition, warned that erosion of several defense industries might leave the nation naked to its enemies.

The Fuhrman Report calls on the President to make sure the Pentagon is more directly involved in shaping the nation's economic policies. This startling idea is based on the theory that innovativeness gives the US a technological edge on the battlefield as well as in the marketplace. The report further urges the President to issue an Executive Order or National Security Decision Directive establishing an Industrial Policy Committee, to be led by his national security adviser, and including Pentagon representatives.

The proposal, coming amid all the other advice that President-elect Bush and his transition team is receiving, is bound to be controversial. Many would argue that DOD already plays an important part in economic actions by its contracting and procurement practices. The concept, if adopted, would inject the military into an unfamiliar policy realm and would mark a distinct departure from the Pentagon's customary approach to stimulating advances in weapons technologies and manufacturing techniques.

The findings and recommendations of Fuhrman's panel have the backing of a prominent group of scientists, businessmen and academics, including William A. Anders, senior executive vice president of Textron Inc; Norman Augustine, CEO and vice chairman of Martin Marietta; Solomon J. Buchsbaum, executive vice president of AT&T Bell Labs; John M. Deutch, provost of MIT; Jerry Junkins, president and chief executive of Texas Instruments; Mark Miller, president of Boeing Aerospace; Donald H. White, president and CEO of Hughes Aircraft, and three former Pentagon assistant secretaries for research and development.

This panel also urges DOD to strengthen the creative energy of industry. DOD can do this, says the Fuhrman Report, by supporting industrial consortiums to explore the frontiers of science and technology, by promoting cooperative research programs for universities and private firms and by enabling government laboratories to transfer promising technologies far more freely to commercial companies.

Benefits of military spinoffs

DOD has traditionally supported de-



Fuhrman: Expanding DOD's objectives

fense-related R&D through direct financial assistance, incentives to enhance manufacturing capabilities and procurement contracts that provide technological advances for developing specific military systems. Military analysts like to boast that the civilian economy benefits from spinoffs of defense programs. The new plan would reverse the process, but emphasizes policies that would benefit US high-technology industries as a whole and, to be sure, would benefit high-technology fields.

The report was discussed with Defense Secretary Frank Carlucci by members of the science board on 18 October. It is the latest in a series of reports that have concluded that traditional approaches to military contracting and procurement are now inadequate. The proposed Industrial Policy Committee would seek ways to offset the erosion of US technological leadership by the nation's allies as well as its potential adversaries.

The proposal could increase Pentagon influence over a variety of policies, including university research programs, education, environmental regulation and tax and trade laws. In addition, the Pentagon's link to the nation's economic policies would be strengthened, the report suggests, if the Defense secretary became a member of the Economic Policy Council.

Until now, says Richard DeLauer, a former undersecretary of Defense for research in the Reagan Administration's first term and a member of the Fuhrman panel, the Pentagon has been at best a junior partner to the Commerce Department in determining government policy toward industries that affect national security.

The Defense secretary, he said, "has to be an important member of the economic decision-making process. The Defense Department's point of view should be a strong influence on decisions."

Many economists worry, however, that the Pentagon already is far too pervasive in economic decisions. A business analyst, Sean St. Clair of Duff & Phelps Inc, argues that the department has enough problems dealing with inefficiency and corruption in its own operations without taking on new ones involving private industry. "I'd like to see the whole Pentagon bureaucracy revamped," he says. "A more efficient system would stimulate the economy."

By encouraging certain fields and technologies and funding research and manufacturing, DOD might increase the nation's security. "National security is not something that happens independent of the rest of the economy," says L. Douglas Lee, chief economist for Washington Analysis Corp. In the past, claims Lee, DOD has encouraged cutthroat competition among rival contractors—a tactic, he says, that had caused defense industries to make inaccurate bids and forced some out of business altogether. In addition, some contractors, worried about tighter profit margins, have merged or fallen prey to takeovers, thereby shrinking the defense industry base still further.

Fears about industrial vulnerability convinced Congress of the need to set up Sematech. Earlier this year, Congress approved DOD's plan to contribute \$100 million in fiscal 1989 to Sematech, an industrial consortium organized to improve R&D in semiconductors, a field considered vital to defense electronics. The Pentagon is represented on Sematech's technical advisory board and the organization shares its plans with the military. DOD expects to provide two-fifths of the funds for Sematech in the next five years, after which the consortium will be sustained entirely by member companies. Pentagon officials see Sematech as a model for other industries in need of stimulation.

More assertive DOD efforts to boost the US economy come none too soon, according to David Packard, co-founder of Hewlett-Packard and deputy Defense secretary in the Nixon Administration. He suggests that Bush should choose a business executive rather than a political ideologue to head DOD. Packard, who led a study three years ago into Pentagon reforms, endorses the conclusions of the Fuhrman Report.

—IRWIN GOODWIN ■